A compact design of in-plane channel drop filter using degenerate modes in 2D photonic crystal slabs

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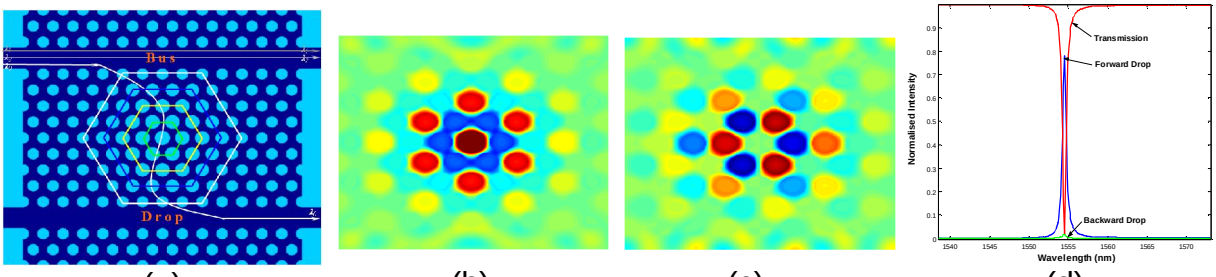
We have recently designed an in-plane channel drop in triangular-lattice 2D photonic crystal slabs. The system consists of two conventional waveguides and a cavity system. Three-dimensional finite difference time domain simulations have shown that the power transferred to the drop waveguide is 78% and only 1.6% is left in the bus waveguide. The quality factor is around 3,000. By tuning surrounding air holes, the light remaining in the bus waveguide can be further reduced to 0.3% at resonance.

The cavity is constructed by carefully arranging the radii of some periods of air holes into a graded pattern and involves no missing air holes [1]. This cavity supports two modes of opposite symmetry, one even with respect to the central plane perpendicular to the waveguides and the other odd. Since both modes remain even with respect to the central plane parallel to the waveguides, the transfer occurs along the forward direction of the drop waveguide [2]. The presence of Bus and Drop waveguides does not affect the vertical light confinement of the cavity and both modes keep high vertical Q values (>35,000). By tuning the radii properly, the two modes can achieve degeneracy with the same resonant wavelength. Moreover, both modes prove to couple equally into the waveguides and have similar coupling Q values (~3,000). Since the vertical Q is much larger than the coupling Q, the vertical loss of the system is kept low.

We believe this novel and compact design is adequate for dense wavelength division multiplexing applications in modern optical networks.



(a) (b) (c) (d)

Figure (a) top view of the system. (b) $\mathbf{H_z}$ field of the even mode at central slab plane. (c) $\mathbf{H_z}$ field of the odd mode at central slab plane. (d) intensity spectra.

[1] K. Srinivasan and O. Painter, *Optics Express*, **11**, 579 (2003).
[2] S. Fan, P. R. Villeneuve and J. D. Joannopoulos, *Optics Express*, **3**, 4 (1998).